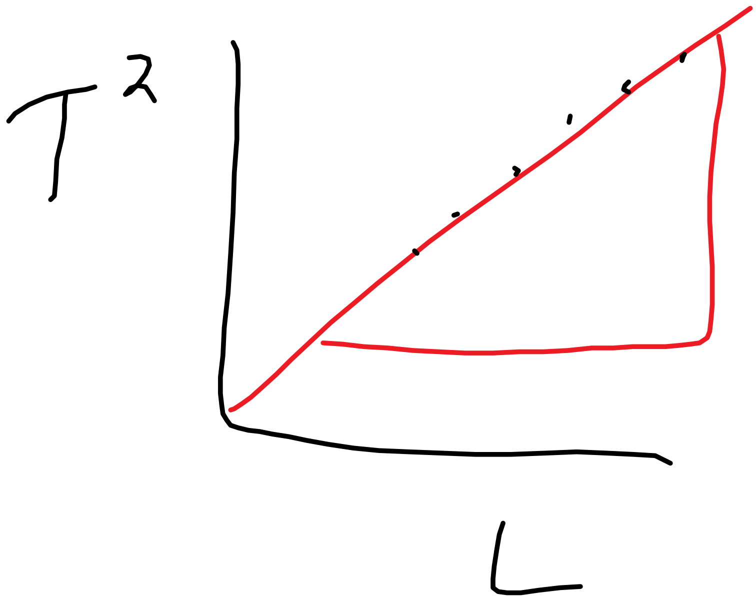


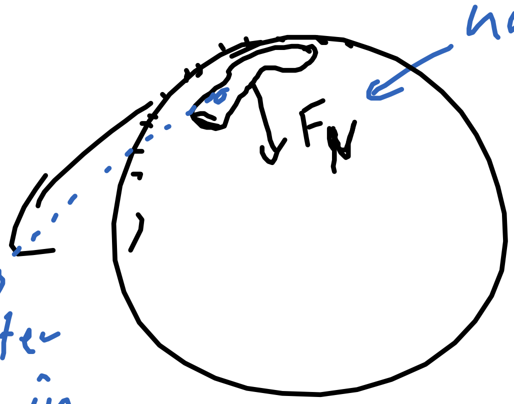
Slope = $\frac{\text{rise}}{\text{run}}$

$= 4.8 \frac{s^2}{m}$

% error = $\frac{4.8 - 4.0}{4.0} \times 100$

$= 20\%$

p119 Q1

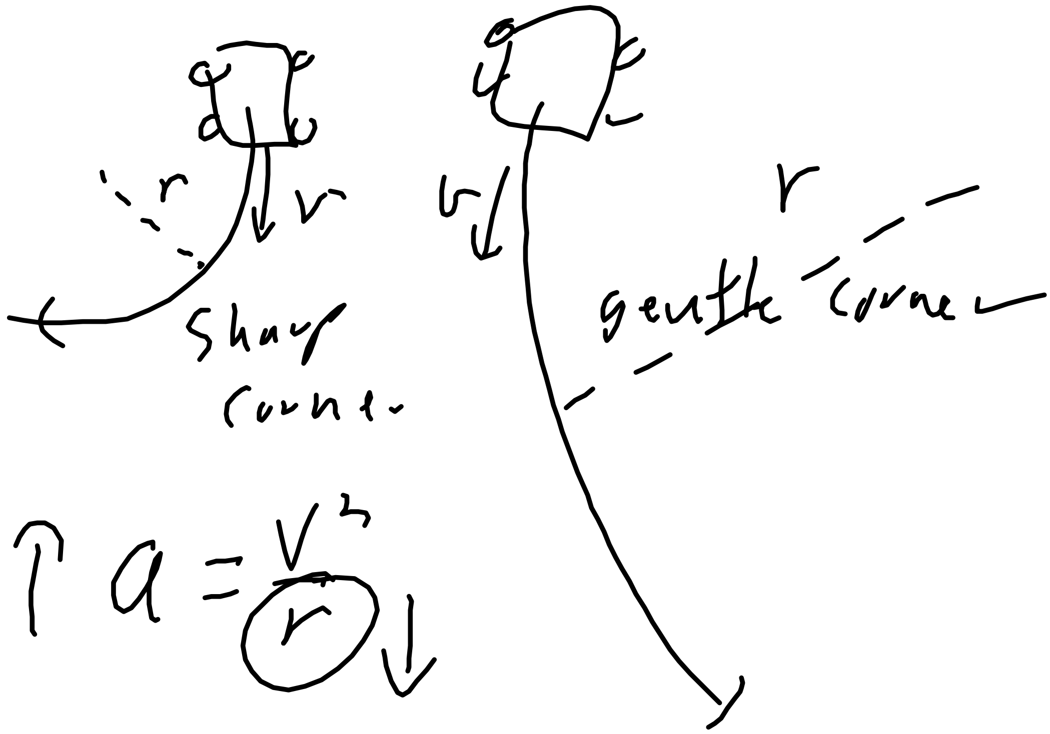


normal force pushes the sock into a circular path

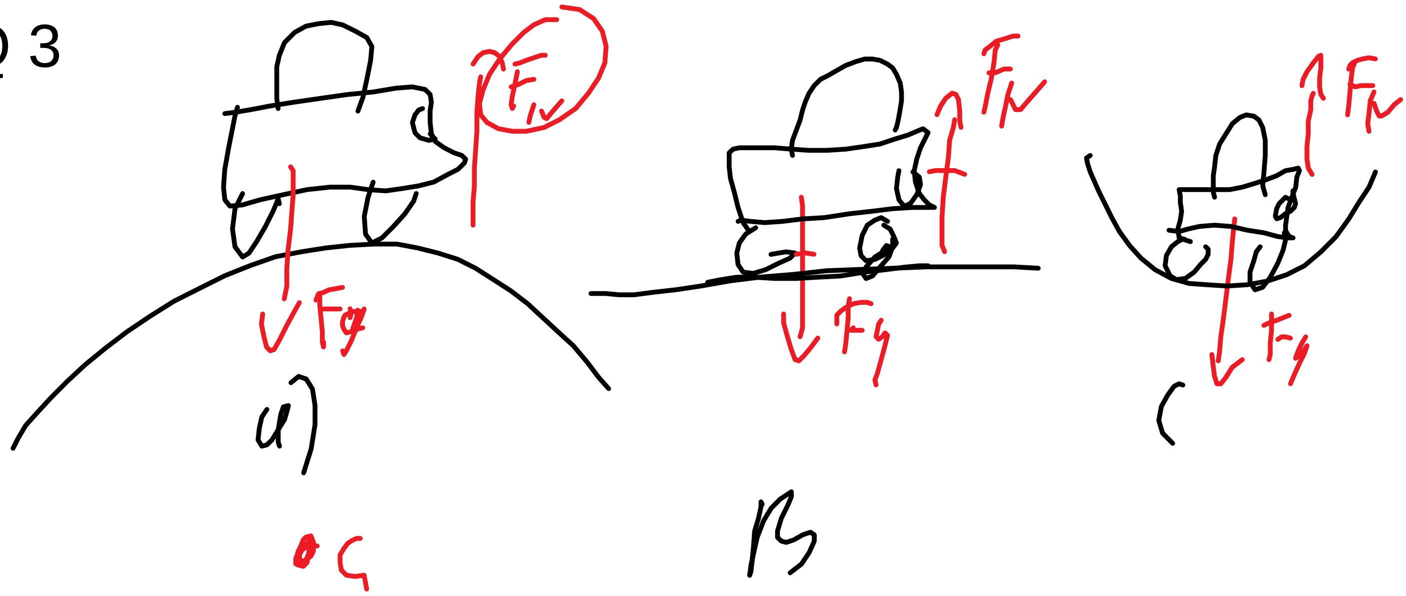
water goes in a linear path through holes

The inertia of the water carries it out. This is a better explanation than the centrifugal force.

Q2



Q 3



in uniform circular motion, the net force is towards the centre of the circle.

for a) the net force is down and

F_{net} = Fg - F_N so $F_N = F_g - F_{net}$ so F_N is smaller then F_g

but for c the net force is up, so

$F_{net} = F_N - F_g$ so $F_N = F_g + F_{net}$ so F_N is bigger

then F_g
so the larges F_N is c

Q4 on a merry-go round - normal force up, gravity down, force of the horse on your leg sideways - causing centripedal force.

Q5
The water falls with g but is moving fast enough that the rate it falls matches the curve path.

- Like the moon is moving fast enough that it falls in orbit but not on our head.

Universal Gravitation, F_g = ?

What is gravity?
Aristotle - thing that causes stuff to fall.

Newton - Force between any two masses.

$F_g = mg = GMm/r^2$
m is any mass
g is the gravitational field strength, in N/kg.
M is any mass
r is the distance between the centre of masses M and m, in metres.
G is the universal gravitational constant, valid everywhere in the universe.

6.67×10^{-11} Nm^2/kg^2

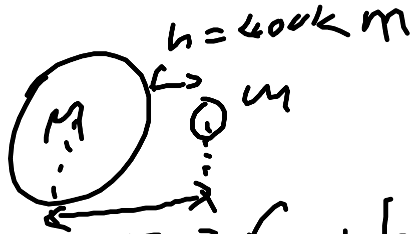
Bonus:
Einstein - gravity is curvature in space-time - causes changes in how time flows.

Dark Matter/Dark Energy? -
Dark Matter - if you look at the rotation of galaxies they don't match predictions, so scientists hypothesize more matter than we see.

Dark Energy - Galaxies seem to be moving apart faster than before, scientists hypothesize extra energy causing that acceleration.

1. The international space station is 400 km above the surface of the Earth, on average.

a) determine g at that height.



$r = r_E + h$

$r = 6.38 \times 10^6\,m + 4.00 \times 10^5$

$r = 6.78 \times 10^6\,m$

$$F_g = mg = \frac{GMm}{r^2}$$

$$g = \frac{GM}{r^2} = \frac{\left(6.67 \times 10^{-11}\,\frac{Nm^2}{kg^2}\right)\left(5.98 \times 10^{24}\,kg\right)}{\left(6.78 \times 10^6\,m\right)^2}$$

$$\boxed{g = 8.7\,\frac{N}{kg}}$$

b) what is the force of gravity on a 1.0 kg mass at that height.

= 8.7 N

c) why do astronauts appear weightless?

The station and the astronauts are falling together - in free fall. Weight = 8.7N/kg x m but the apparent weight (normal force) is 0.

a) how fast is the station moving around the Earth?

$$a = \frac{v^2}{r} = g$$

a) What is the period of revolution of the space station?

$$a = \frac{4\pi^2 r}{T^2} = g$$

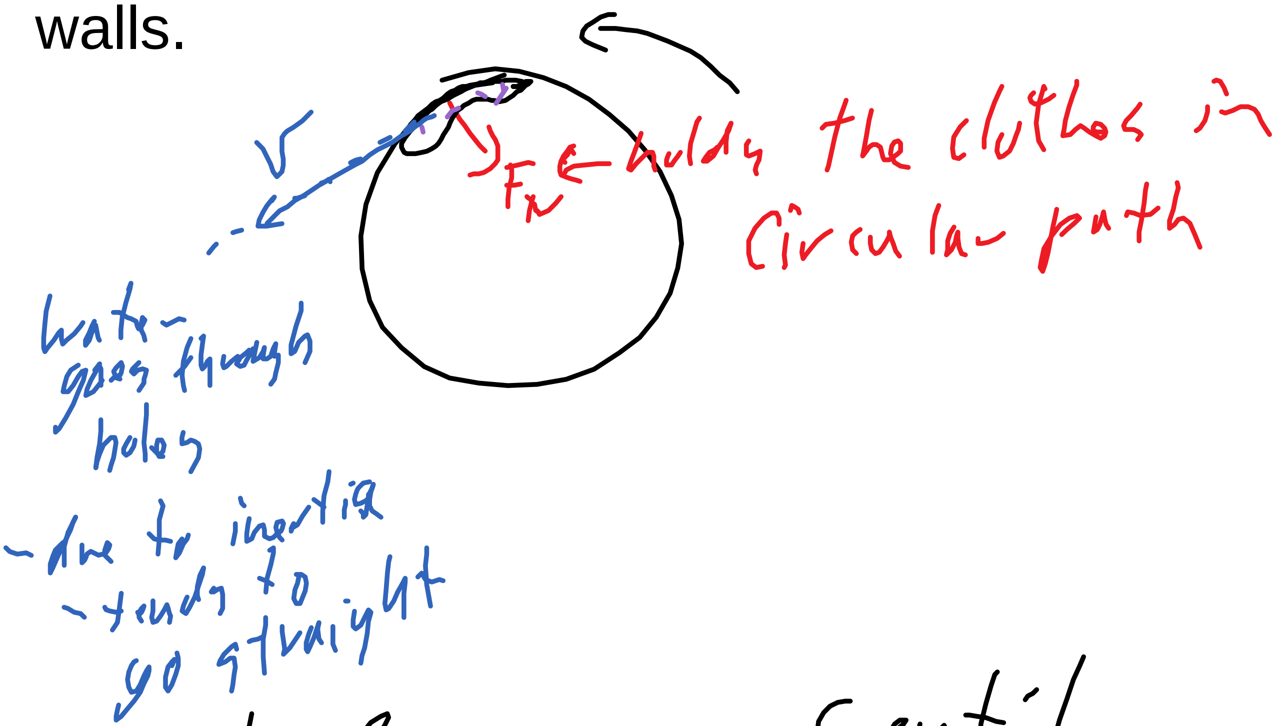
a) What is the height of geostationary satellites?

P122 Q21-33 odds
Quiz Wednesday Nov 16th Circular Motion

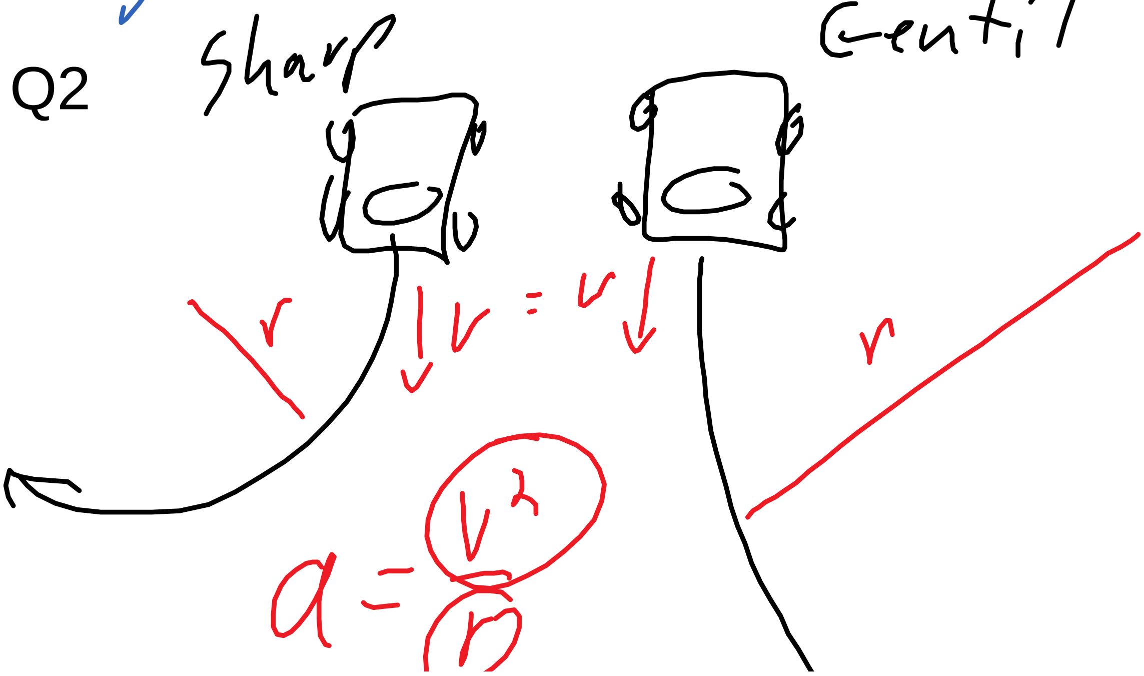
p119 q1-5, 1-15

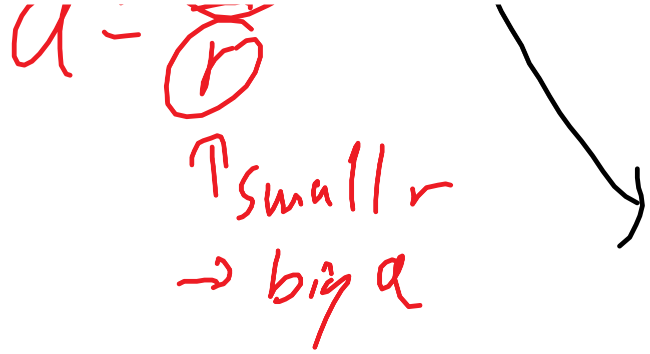
Q1
Is water thrown out of a dryer by centrifugal force?

No, the velocity of the water is tangent to circle, the water goes through the holes in the wall but the clothes are pushed in circular path by the walls.

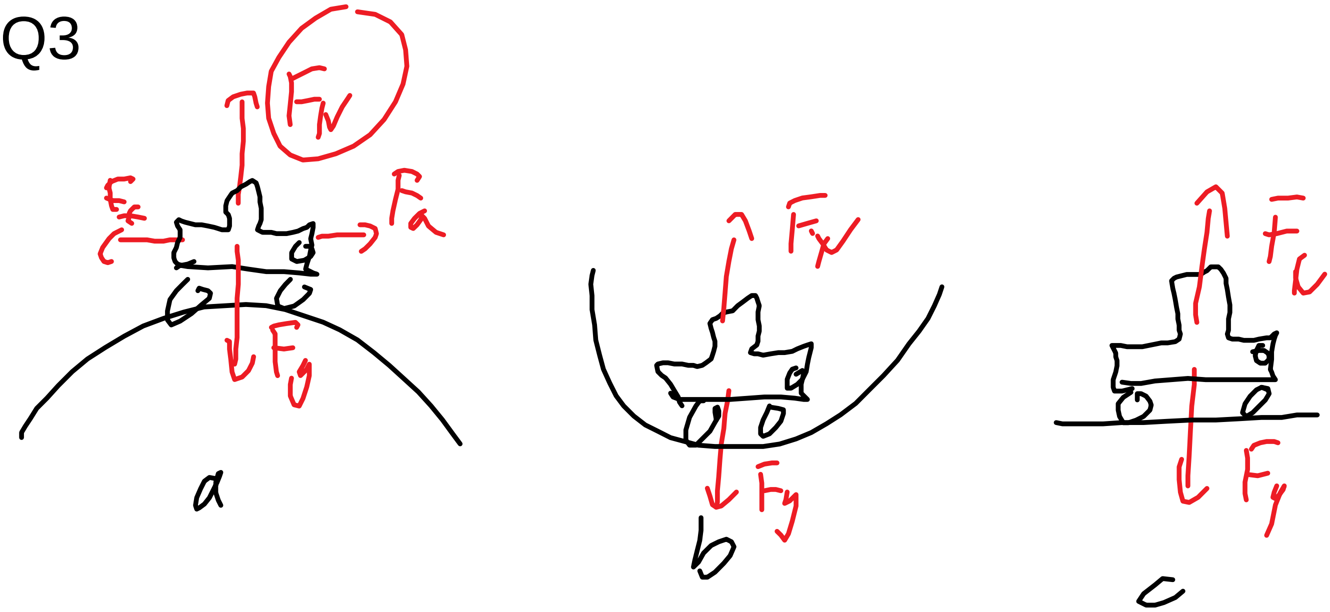


Q2





Q3



Centripetal force is towards the centre of the circle and is the vector sum of all forces.

for a) $F_g - F_N = F_{net}$ (down)
$F_N = F_g - F_{net}$ so F_N is less than F_g

for c) $F_N = F_g$ there is no acceleration

for b) $F_N - F_g = F_{net}$ (up)
$F_N = F_g + F_{net}$

Gravity

What is gravity?

Aristotle - philosopher 300BCish - gravity pulls stuff down - more mass = faster

Galileo 1600 ish - stuff falls at the same rate, if air resistance is negligible

Newton - 1700 ish - All masses pull each other together.

$F_g = GMm/r^2 = mg$ g is the gravitational field strength.

F_g is the gravitational pull between any two masses, in Newtons, N.

M and m are any two masses, in kg.

r is the distance between the centre of the two masses, in metres.

G is the universal gravitational constant - valid everywhere in the universe.
$6.67 \times 10^{-11} Nm^2/kg^2$

Bonus - Einstein - gravity is a warping in space-time - causes changes in time.

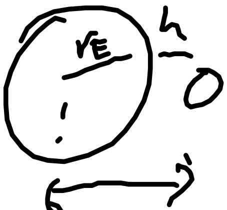
Dark matter - observations on rotating galaxies

show rotation rates not consistent with observed mass - so hypothesize dark matter causing the increased rotation.

Dark Energy - observations show galaxies accelerating, so we hypothesize dark energy giving the extra kinetic energy.

eg. the international space station is 400km away from the Earth, radius 6.38×10^6m and mass 5.98×10^{24}kg. What is

a) g at the space station



$$F_g = \frac{GMm}{r^2} = mg$$

$$r = r_E + h$$

$$g = \frac{6.67 \times 10^{-11} \frac{Nm^2}{kg^2} \; 5.98 \times 10^{24} kg}{(6.38 \times 10^6 + 4.0 \times 10^5)^2} = 8.7 \frac{N}{kg}$$

b) Fg on a 70 kg astronaut.

$F_g = mg = 70 \times 8.7 = 609$ N $= 6.1 \times 10^2$N

c) why does the astronaut feel weightless?

They are falling towards Earth but they are moving fast enough that the rate of falling corresponds to the curvature of the orbit.

apparent weight is the F_N or F_t , not the actual

weight.

d) how fast is the space station moving if it is in uniform circular motion around the Earth?

e) what is the period of revolution?

f) how far away are geostationary satellites?

p122 Q 21-33 lab report